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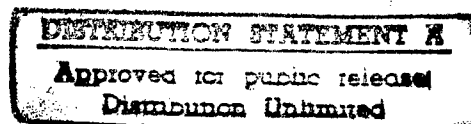
SOVIET INDUSTRIAL DEVELOPMENT

NO. 13

SELECTED TRANSLATIONS

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SOVIET INDUSTRIAL DEVELOPMENT

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Introduction

This is a serial publication containing selected translations on industrial development in the Soviet Union.

Basic Problems in the Fuel and Power  
Balance of the USSR

Following is a translation of an article by M. A. Styrikovich in Izvestiya Akademii Nauk SSSR, Otdeleniye Tekhnicheskikh Nauk, Energetika i Avtomatika (News of the Academy of Sciences USSR, Department of Engineering Sciences, Power and Automation), No. 1, 1960, pages 3-11.<sup>7</sup>

The current reorganization of the fuel and power balance of the Soviet Union conducted in accordance with the decision of the 21st CPSU Congress, is of a tremendous national-economic importance. The considerable increase in the percentile share of the petroleum, natural gas and cheap fuels mined by open-strip methods will make it possible to reduce considerably the capital investments in mine construction and to curtail the extraction of the most expensive solid fuel. The pace of construction of new thermal electric power stations burning cheap fuels should increase, and at the same time the share of investments in hydroelectric power construction should decrease through the cancellation of the construction of the most expensive and uneconomical hydroelectric power stations.

Naturally, all such reorganization cannot be completed to its full extent within the present seven-year period [by 1965]<sup>7</sup>, because of the considerable commitments already made in both mine and hydroelectric station construction, and therefore, not infrequently, new output capacities will be activated during the seven-year period in objects whose new construction would now be deemed inexpedient.

On the other hand, the dynamic growth in the extraction of petroleum and, particularly gas, requires a commensurate development of other branches of the national economy, especially oil refining and tube production, which also cannot be executed completely within the seven-year period.

There is no need to discuss the over-all importance of the reorganization of the power and fuel balance. It is sufficient to mention that despite the impossibility of the completion of that reorganization within the seven-year period and the necessity of expending a part of the saved funds on measures for financing such a drastic turn-about, over 100 billion rubles in current and capital expenditures will be saved for the national economy during that period by initiating that reorganization. Therefore, the reorganization of the fuel and power balance should be prompted in

all ways, because every year of delay will incur colossal losses.

Under these conditions it is very important to intensify the scientific development of the general problems of the fuel and power balance; also, it is necessary to revise a large number of conventional concepts -- with the revision to be based not only on experience and engineering intuition but also on painstaking scientific elaboration.

The situation is complicated by the fact that the reorganization of the fuel and power balance is accompanied by a great leap forward in the field of the chemical industry, and, in this connection, the particularly dynamically expanding branches of chemistry are precisely those which are based on the use of liquid and gaseous fuels as raw materials.

This naturally poses the question of the extent to which fuel should be considered in the fuel and power balance as not only an energy source but also a chemical raw material. It should, however, be noted that the scales themselves of these two types of production based on fuel are not mutually comparable. In effect, the giant petrochemical industry of the United States of America, which now provides over one-half -- in terms of value -- of the entire output of the chemical industry of that highest-developed capitalist country, absorbs as a raw material only about one percent of the total extraction of petroleum and several percent of the extraction of natural gas.

Analogous ratios will apparently exist in our country also. Therefore, while they need not be regarded as a major factor the problems of raw material utilization are fundamental to petrochemistry, on the scale of the over-all fuel and power balance.

Considering now the individual details of the fuel and power balance directly, and primarily the economics of power resources and the problem of the satisfaction of demand, it is necessary to say a few words about the configuration assumed by our fuel and power balance during the last few decades. Then it will be seen that essentially its reorganization is a perhaps somewhat tardy but perfectly natural embodiment of the shifts -- technical and economical -- which have occurred in the Soviet Union in the last few decades.

As is known, before the Revolution the principal trend of the fuel and power balance in our country consisted in a broad utilization of firewood, Donets and, partly, imported coal and Baku petroleum. The concentration of the production of mineral fuel within individual regions had caused the fuel balance to be warped in character.

Therefore, the first national-economic plans had already devoted very great attention to the rationalization of the fuel and power balance. Under the coeval conditions, when transport used to be very expensive and a surplus rural manpower used to exist, emphasis was naturally placed on the utilization of local fuels, because this made it possible to attain lower outlays on the extraction and processing of fuel. Under these conditions, the role of local fuel grew rapidly while the role of the Donets Basin and Baku diminished.

However, during the last 10-20 years the picture had changed drastically, and a number of traditional concepts ceased to apply to the new economic situation.

In effect, despite the enormous effort applied to the mechanization of the underground extraction of coal, the cost of the coal mined underground has been steadily rising while the labor productivity involved in its extraction has been rising at a much slower pace. This was attributed to complications in the geology of extraction, as a result of the exploitation of low-grade seams, to the circumstance that under the conditions of an improvement in the living standards in the countryside and a shortage of manpower it has become necessary to raise considerably the wages for underground labor, and also to the great difficulty of applying large-capacity machinery to underground extraction.

At the same time, labor productivity in open-strip mines, where large-capacity machinery -- easy to operate on the surface -- has been introduced has increased more than sixfold within ten years. Of course, this has resulted in a relative and even absolute increase in the costs of the coal mined underground and an extraordinary decrease in the costs of the coal mined by open stripping. Open-strip mining, which had started out on a small scale, is now being organized in many of the country's regions, especially in the East where a number of such deposits yield a very low-cost coal. The unique deposits in the Kansk-Achinsk Basin now yield an extraordinarily cheap fuel and literally every year this introduces new downward revisions in the estimate of the long-range cost of fuels.

Naturally, the appearance of such extremely cheap fuels exerts a tremendous influence on the development of the entire fuel industry and the entire national economy of the Soviet Union, particularly when it is considered that these deposits contain enormous reserves and that their extraction can be conducted on a nearly unlimited scale.

The costs of petroleum are decreasing steeply, particularly in comparison with the coal mined underground.

It is sufficient to mention that while in the beginning

of the 1930's the extraction costs of petroleum (per ton of nominal fuel) were on the average higher than those of coal, in 1939 they amounted to only 60 percent of the extraction costs of coal, and at present they are already less than one-third. However, it should be kept in mind that the capital investments in the prospecting for and extraction of petroleum are fairly high in comparison with the investments in open-strip mining of coal, and until the last decade they had greatly exceeded even the investments in the underground mining of coal as well. It was only in the last 10 years that the new technology of extraction and the discovery of deposits with unique indexes had made it possible to reduce these capital investments. At present, in a number of principal regions such as Bashkiriya and Tatarsiya, the capital investments in new enterprises amount to approximately 200 rubles per ton of nominal fuel, i. e., no higher than the capital investments in the underground mining of coal in most regions; moreover, the running expenses of petroleum extraction are much lower.

Therefore, the "rated" cost, which can be defined as a value close to the price of production (current expenses plus amortization of capital investments corresponding to an eight-year period of recoupability) for the petroleum of the Ural-Volga region is generally of the order of 40 rubles per ton of nominal fuel, whereas the rated cost of the coal mined underground equals approximately 100 rubles in the Donets Basin, and even in the Kuznetsk Basin it is as high as about 60 rubles.\*

Thus, the cost of petroleum is plummeting and sizable deposits of very cheap petroleum are appearing. Of course, petroleum is a specific fuel, assigned largely for refining into high-value grades of special fuels and lubricants. However, in view of the possibility of a rapid expansion of the extraction of cheap petroleum it would not be expedient to restrict the scale of that extraction to the scale of the demand for light petroleum products obtainable through the refining of petroleum "in depth."

It is necessary to investigate whether it might not be more economical to expand the extraction of petroleum while at the same time curtailing the extent ("depth") of its refining, as this would make it possible to provide the country, in addition to a fixed output of light petroleum products, with an additional quantity of furnace mazut. Here it should

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\*Recently new prospects have appeared for a considerable reduction in the cost of the coal mined underground (hydraulic extraction).

be considered that the capital investments in petroleum refining drop very steeply when the yield of light petroleum products is reduced and the yield of mazut is increased.

It is known that enormous deposits of gas have recently been discovered in our country. These deposits provide an exceptionally cheap fuel in situ of extraction; according to preliminary estimates, the production cost of gas on the larger deposits is of the order of 10 and less rubles per ton of nominal fuel direct on the extraction site, and the related capital investments into new enterprises are of the order of 110 rubles per ton of annual extraction.

All these changes have resulted in the appearance of a number of regions in which fuel is extremely cheap, in which fuel cost is four or five times less than the average for the Soviet Union as a whole according to summation indexes taking into account both the capital investments and current expenditures. Such a colossal reduction in the cost of a number of fuel grades in certain regions, coupled with the large scale of extraction, causes the development of extraction in the expensive deposits to be no longer expedient. In a number of cases it also proves expedient to shut down those existing coal mines in which current expenditures are particularly high, even though this may involve the forfeiture of large capital investments and create difficulties in connection with the need for diverting elsewhere the thereby relieved labor force.

Another characteristic feature is the drastic decline in the costs of all types of transportation. Usually much is said about the achievements in the wire transmission of electrical energy and the achievements in pipeline transport, but it should not be forgotten that rail transport is also very much alive and growing in our country.

A characteristic example could be cited. In 1913 the shipping of Donets Basin coal for a distance of 1,000 kilometers cost one and one-half times more than the extraction itself of that coal, while in 1940 it fell to as little as 70 percent of the extraction cost, and in 1954 -- to 26 percent; in 1965 it will cost only 18 percent of the extraction cost. Thus, although previously -- what with the level of technology bequeathed to us by Tsarist Russia -- the 1,000-kilometer transfer of Donets coal used to cost so much that it was more profitable to develop the Sub-Moscow Basin for supplying Moscow, at present when the transportation cost will decline to nearly one-tenth in comparison with extraction cost in the immediate future, it becomes more profitable not to develop the Sub-Moscow Basin and instead to import cheaper coal, over distances of as much as two or three thousand kilometers, from other regions.

The wire transmission of electrical energy has also made great strides. It is as yet difficult to obtain sufficiently reliable data which would make it possible to compare the long-term cost of the rail transport of coal with the analogous cost of the wire transmission of electricity. This is because of the presence of a number of technical difficulties in the evaluation of the indexes of future electricity transmission -- difficulties stemming from the fact that we should base such transmission on ultrahigh-voltage alternating current or direct current, i. e., anticipate a transmission profile which has not yet materialized on the industrial scale; therefore it is difficult to assess in advance the cost of such transmission. However, the principal difficulty consists in a number of general methodological problems which still require a great deal of study. For instance, when we plan for the end of the seven-year period a line extending from Ekibastuz through Akmolinsk and Kustanay to Troitsk for transmitting to the Urals the electrical energy generated by the burning of Ekibastuz coals, then such a line -- which interconnects a number of power systems en route -- would make it possible within these systems to abandon the construction of small unprofitable stations, would facilitate the transfer of power from system to system to satisfy peak loads, etc. Thus there arises the question of what part of the value of that line should be related to the in-transit transmission of energy, and what part -- to the above-indicated additional advantages.

A completely analogous question arises also with regard to the railroads. The mass hauls of coal hinge on increasing the traffic capacity of railroads, which can be achieved both through the construction of additional trackage and through the electrification of railroads, and through the laying of new lines as well. On the most important coal transport routes (e. g., Siberia--Urals) it is possible to conduct the construction of new rail lines mainly for coal-transport purposes, and at the same time such new lines will provide a tremendous impetus to the development of the regions they cross, and they will serve as a means of hauling a large number of other types of freight.

The question of transmitting gas through pipelines is very important. Incontestably, natural gas can be transmitted over long distances at a relatively low cost even at a large volume of transmission, but still, tempestuous disputes arise whenever it is necessary to provide cost indexes with an accuracy of even up to 20 percent; this is because the pipeline transport of gas has begun to develop in the USSR only very recently and the experience in the construction of superlarge-capacity gas pipelines is still scanty. According



to the currently available data it is possible, as a first approximation, to count in the long run on electronic transport, rail conveyance of high-calory coal and transmission of natural gas along large-capacity pipelines by methods of energy transportation involving approximately identical costs.

The long-distance transmission of petroleum is approximately twice as cheap in terms of both current and capital expenditures than the transmission of gas through large-capacity pipelines or the rail transport of high-calory coal. But this pertains, as a rule, to the pumping of crude petroleum. And this, in turn, is related to the problem of the geographical distribution of petroleum refineries on the territory of the Soviet Union and consequently to the transmission to various areas of not only mazut but also light petroleum products. In this connection it becomes necessary to interrelate the demands of individual regions for mazut and light petroleum products with the question of constructing petroleum refineries. By now, definite difficulties and disproportions exist here. As is known, proposals exist for making the seven-year period a period of a substantial additional expansion of petroleum extraction and curtailment of the extent of petroleum refining, i. e., a period of a high yield of mazut and small yield of light petroleum products.

Proposals have been offered for refining the additionally extracted petroleum in simplified plants near the extraction site -- in the Urals -- and, together with these plants, for constructing large-capacity mazut-burning electric power stations.

Should these proposals be adopted, the plants designed for a high output of mazut would be built in the region of the Urals, where mazut as a power-generating fuel can meet with competition by the Siberian coals delivered by rail transport and by the transmission of electrical energy from Siberia, considering the moderate costs of both to the user. At the same time, refineries with "in-depth" refining -- i. e., with a low yield of mazut -- are planned for construction in the Northwestern regions of the country, which lack a cheap local fuel and which can be supplied only either with gas through superlong-distance pipelines or with Donetsk coal beyond the regular radius of transport, so that as a result the mazut-replacing fuels there are expensive. In such regions it would rather be necessary to produce a maximum amount of mazut, i. e., to build refineries for a simplified processing of crude.

The solving of all these problems requires a thorough coordination of the fuel and power balance of the country as a whole, inclusive of the problems of exports and imports. When long-distance transport is developed to a degree at which

petroleum will be transmitted along pipelines from the Volga Region to East Germany and Czechoslovakia in one direction and to Irkutsk (and perhaps farther) in another direction, and when serious consideration is given to the question of constructing an electric transmission line more than 2,000 kilometers long connecting the Kansk-Yenisey region with the Urals -- then it is not possible to consider nearly any region of the Soviet Union as an isolated one. The fuel and power balance of individual regions then has to be regarded from the standpoint of the country as a whole, because, e.g., the question of whether the flow of mazut will proceed westward or eastward will affect the development of the Donets Basin region, (i. e., it will, in turn, affect the question of whether to build or not to build new mines for power-generating coal in that Basin); it will likewise affect the pace of development of the open-strip mining of cheap coals in Siberia and the question of how to develop the extraction of gas in Central Asia as well. Thus, it becomes clear that nearly all principal regions are closely interrelated and that only a correct consideration of the needs and resources of the Soviet Union as a whole will make it possible to determine the optimal distribution of fuel and power, and hence also the geographical distribution of all power- and fuel-consuming enterprises on the territory of the Soviet Union.

Only well-founded balance-sheet long-term relationships can make it possible to indicate the future appearance of new stable zones of cheap additional power, at an optimal distribution of all resources throughout the country. This concerns precisely additional power, because every region may contain a number of power types -- some of which very inexpensive ones. But the important thing is not this -- it is necessary to know how the subsequent demand will be satisfied after the exhaustion of these very inexpensive but limited resources. It is necessary to create a technical-economic map of the Soviet Union which would make it possible to determine the zones of expensive and inexpensive replacement fuel, on taking into account the economic effectiveness of its transport and of the transmission of electrical energy. This is an unusually intricate problem, but it must be resolved, because its disregard would lead to immense proportions and colossal overexpenditure of funds on the scale of the Soviet Union as a whole.

Of course, even at an optimal distribution of all this throughout the territory of the Soviet Union we will still be left with a number of regions in which fuel will be very inexpensive and regions in which fuel will be relatively expensive or even very expensive. True enough, there now exists a way of eliminating the comparatively small regions of very

expensive fuel -- meaning atomic energy, which is virtually not subject to any transport limitations and which, in measure with the gradual decline in its costs (as yet it can still hardly compete even with the expensive types of fuel), will increasingly replace other forms of energy in the regions where fuel remains expensive. However, it should be noted that the prospects for a broad use of atomic energy in the next few years are rather limited, considering the sharp decline in the costs of fuel and the rapid progress in thermal electric power stations. It can be assumed that the principal skirmish on the economic front, into which we engage with the leading capitalist countries, will be won in the field of power development, and that fundamentally it will be won not through the use of a basically new weapon in the form of atomic and thermonuclear energy but through the perfection of our old weapon -- thermal electric power stations burning organic fuel.

In addition to the ways of satisfying the demand for fuel and power, a proper distribution of fuels to users is also of major importance. This is an extraordinarily important problem, because the relative effectiveness of various grades of fuels differs very sharply according to which users consume them. For instance, it could be pointed out that transition to liquid fuel will be of the greatest benefit to water and rail transport. Such transition makes it possible to use more convenient engines, by supplanting steam locomotives by diesels. Besides, even those steam locomotives which will still function in 1965 and later will benefit so immensely from the transition from coal fuel to liquid fuel that the freight cost will decline even if a ton of nominal fuel in the form of liquid fuel costs 2.5 times as much as in the form of solid fuel.

To technological users, the transition to liquid fuel will yield a varying effect according to the nature of their technology, although for many users the technology is sufficiently high. On the other hand, the existing large electric power stations will derive little benefit from the transition from solid to liquid fuel.

In effect, the capital investments have already been made; true enough, their personnel was reduced, but the role of wages and salaries in the total amount of expenditures by large modern electric power stations is very low; the consumption of power for the stations' own operating needs is a little reduced, and the consumption of fuel remains nearly unchanged. All this taken together yields such a low saving that the transition to liquid fuel can be expedient only if the cost of that fuel is not more than five or seven percent higher than that of solid fuel.

At the same time, the dynamically increasing extraction of petroleum and gas and the insufficient preparedness of users leads to a situation in which these fuels are shipped where they can be most easily and simply used, i. e., to the existing large thermal electric power stations; thus we are confronted with the fact of an unrational utilization of liquid fuel, as it would be more relevant to distribute that fuel to minor users, technological users, and transport.

In a large power industry it is more rational to distribute liquid fuel to new power stations, because by designing these new stations for burning mazut or gas we save approximately 30 percent of the initial costs.

On the other hand, if a new station is assured surplus pipeline gas for the greater part of the year, and if it burns mazut or coal only in the winter, then its operation on mazut yields much higher unit savings, because the same saving in capital expenditures will be achieved at a much smaller annual consumption of mazut.

The reduction in capital expenditures on the principal stations can save a sum equivalent to the change in the annual expenditures on fuel resulting from a decrease of 10-15 rubles in fuel cost per ton of nominal fuel. Thus, a power station operating on gaseous or mazut fuel, which costs 28-33 rubles per ton of nominal fuel, will yield the same national-economic effect as a station operating on Kansk coals, whose rated cost is approximately 18 rubles per ton of nominal fuel. For the peak-load stations with a low annual consumption of fuel or for the peak-load boilers of thermal electric power stations the savings will amount to 4-50 rubles per ton of nominal fuel. However, when deciding the question of the fuel basis of a power station, it is of major importance to determine the course of the long-term balance, because a saving in capital expenditures is attained only when constructing a station designed specifically for burning gas or liquid fuel without providing for the possibility of its conversion to solid fuel, i. e., it is necessary to be certain that the burning of gas and liquid fuel will remain expedient not only at present but throughout the entire lifetime of that station. Of course, it is possible to arrive at intermediate solutions by designing the station for burning gas or mazut but providing for the possibility of its eventual conversion to burning solid fuel, but then the savings will be smaller and they will fundamentally consist in the possibility of postponing a part of the expenditures till future years.

Of great importance is the conversion of minor users to gas, and in this connection, decentralized users, to whom it would not be expedient to extend the gas network and who

should be supplied with fuel by motorized transport, ought to be provided with compressed gas.

An important aspect of this problem is the ease of conducting the total automation of the performance of the installations operating on liquid fuel, especially on gas, with the concomitant disbanding of the tending personnel, which would be difficult to achieve in operation on solid fuel or, at any rate, could be achieved only at a very rigorous upgrading of solid fuel.

The possibility of the conversion of minor users to compressed gas and liquid fuel plays a very significant role and it could yield tremendous savings of manpower, but it should be kept in mind that in our country not all of the related special equipment has been developed and the necessary apparatuses are not yet manufactured in sufficient quantities.

An enormous role is played by the fact that we are displacing quality solid fuel by liquid fuel and gas among the minor users. To be sure, solid fuel is a very conventional concept which depends on the user. The minor user, when burning solid fuel, poses very strict requirements to fractional composition, especially for the nonsintering fuels. The currently widespread practice of assigning to small industry and minor users the so-called ARSh antratsitryadovoy so shtybom -- run-of-mine anthracite with culm, which often contains only 15 percent lump anthracite and 85 percent culm, results not in the burning of finely divided fuel but rather in its cremation, because actually the particles smaller than 3 mm nearly completely escape through the flue. In contrast, if that fuel were to be assigned to coaldust-burning electric power stations, there the presence of fines culm would not cause any inconveniences and it even would somewhat facilitate comminution. Therefore, it is of extreme importance to establish reliable relationships in the fuel balance, which still requires much painstaking study. If a surplus of power-generating solid fuel is to be expected in the future, the problem of reducing the yield of anthracite culm and increasing the reserves of lump coal should be regarded as a very important national-economic task. This could be achieved by the nodulization of culm and a drastic revision of the conditions of the screening of anthracites, so as to classify as culm only the fines which are actually not fit for screening (minus 3 mm). But for this purpose it is necessary to alter the screening conditions and to develop screens with electric heating. Lastly, it is necessary to conduct a major research project regarding the revision of mining conditions, because the cutting apparatus of the modern coal cutter-loader yields a very high percentage of coal fines. It is necessary to conduct appropriate studies, e. g., to develop

cutting mechanisms of the chipping type, which will yield less fines.

But there arises the question of how acutely is all this needed. If in the future the coal culm will be absorbed by electric power stations, and if even the middling fractions will be partly assigned to these stations, then neither nodulization, nor precise screening, nor the redesigning of the coal cutter-loader will be necessary. But if a considerable surplus of coal fines is obtained, then conversely all this will constitute a pressing and necessary problem. This shows that the clarification of the problem of culm in the present fuel balance is very important -- however, no reliable data are as yet available.

Of great importance is the problem of the most efficient utilization of natural gas. As is known, gas pipelines make it possible to transmit gas over large distances, but satisfactory economic indexes will then be achieved only if the pipelines are of a sufficiently large capacity, i. e., if a very large amount of gas, say, 14-15 million tons of nominal fuel annually is transmitted over a single route and, moreover, only if the pipeline in question operates regularly throughout the year as well. But gas consumption is subject to sharp daily and seasonal fluctuations. While daily accumulation may cost comparatively little, seasonal accumulation can be achieved only with underground gas storage facilities. In the United States the capacity of these underground storage facilities stands at a colossal figure -- over 20 percent of the annual extraction of gas. In that country, however, depleted gas and petroleum deposits are principally used for such storage, whereas in our country no such deposits exist in the major regions of gas consumption. Other natural gas storage facilities can also be found, but it is difficult to count on a large number of inexpensive facilities of this type.

Under these conditions, the surplus pipeline gas should be assigned to electric power stations which could operate on it in summer and should convert to another fuel in winter. That other fuel could be solid as well, but this is undesirable for the stations situated within the larger urban areas where the abandonment of the use of solid ash fuel is very important to de-polluting the air over the cities. It is better that these stations should be provided with mazut which, even if used only for a part of the year, could lead to a reduction in the initial station costs.

The development of the extraction of natural gas makes very acute the question of the expediency of developing the production of artificial gas derived from solid fuel, especially with regard to the obtainment of the purely power-

generating (subterranean) gas. This last version now appears to be impractical unless the economic indexes of underground gas as a method of extracting power-generating fuel are fundamentally altered. The data of the fuel balance enable us to assume that the construction of new mines of power-generating fuel can be abandoned for a long time throughout nearly the entire Soviet Union. Thus, the future extraction of power-generating fuel will be conducted either in the form of side extraction together with the extraction of industrial coking coals or in the form of open-strip mining, i. e., this will simultaneously serve to solve a major social problem -- the abandonment of underground labor as a source of energy supply. Consequently, in this case, the underground gasification of coals will not serve any social purpose.

Another problem is that of the scale of the production of artificial gas for consumer and industrial needs. Naturally, wherever natural gas is available nearby or can be delivered at low cost, the question of artificial gas ceases to exist. But in our country a number of regions, especially Siberia, are endowed with a very cheap solid fuel and yet lack any discovered deposits of natural gas. To these regions the problem of obtaining consumer gas from coal can be important, but only in the event that no deposits of natural gas are discovered there. Therefore, it is necessary to resolve as soon as possible the question of how reliable are the geologists' assumptions that Siberia itself is a huge [potential] source of natural gas, because, if verified, they will simply nullify the entire problem of obtaining artificial gas in the USSR.

The last problem to which attention should be turned is the role of the mineral part of fuel. Hitherto attention has been intensely focused on the organic part of fuel nearly has not been investigated at all. At present this is becoming a huge problem. Mazut, which we have become accustomed to regard as an ashless material, does indeed contain very little ash but the chemical composition of that ash is extremely unfavorable, and considerable attention should be devoted to this fact. The ash of the high-sulfur mazuts often contains a high percentage of alkalis and vanadium, which leads to the corrosion of metal at temperatures of over 600-650°C.

As applied to gas turbines the struggle against high-temperature corrosion is an intricate problem and, unless that corrosion is combatted, their temperature has to be lowered to the ~ 650°C level, which greatly reduces the efficiency of gas turbines. The efficiency of steam-power installation decreases less greatly but still notably, because high-temperature corrosion can cause great detriment

not only to installations constructed of austenitic steel, when wall temperature reaches  $700^{\circ}\text{C}$ , but also to installations designed of perlitic steel, when steam temperature reaches  $570-580^{\circ}\text{C}$  -- unless the measures for combatting corrosion are developed on a broad front.

Even more complicated is the sulfur situation, because, while sulfurous mazut may contain not more sulfur per calorie than a number of Donets coals and several times less than the Sub-Moscow coal, still, the superlarge-capacity electric power stations (1-2 million kilowatts) expel, each on a single site, such an enormous amount of gases with an appreciable content of sulfur dioxide that it is difficult to count on diluting them to a level acceptable for man and vegetation.

Work is in progress on a version of a 200-meter smoke-stack with high velocities of expulsion which would make it possible to raise a powerful jet of escaping gases to an additional 100 meters above the level of the smokestack, i. e., to raise it to a height at which that jet -- when on dispersing it will touch the ground -- will contain but a tolerable concentration of sulfur dioxide.

However even then it still is necessary to consider what will happen when it is raining -- when the rain will wash these gases and descend in streams of acidified water onto the ground. Therefore, much work still remains to be done with regard to the exploration of other possibilities, e. g., pre-treatment of mazut by pyrolysis so as to extract from it sulfur compounds at a relatively low cost. On the whole, the problem of sulfurous and vanadous mazuts is a major one.

Lastly, coal ash also requires the conduct of large-scale studies, especially at present when a number of fuel with specific ash properties is appearing. Thus, e. g., the Ekibastuz coals extracted in the region of Pavlodar are extraordinarily cheap and burn efficiently, but their ash is very difficultly fusible; it does not fuse even in the very center of the torch, and therefore the mechanically disintegrated, coarse, rugged particles of the flying ash of Ekibastuz coal erode the heating surfaces and prove to be very unfavorable to man from the standpoint of the phenomena of silicosis. This presents the problem of how to melt this difficultly fusible ash, even if only on the surface, in the firebox of a boiler unit. This important problem requires serious study not only by heat engineers but also by silicate chemists, so as to discover inexpensive admixtures which would reduce the melting point of the ash to a level making it possible to use cyclone fireboxes collecting up to 90 percent of the ash.



All the foregoing constitutes but a cursory survey of the colossal number of tasks now awaiting solution in connection with the problem of the fuel and power balance. Special attention should be paid to that problem by the Department of Geologic Sciences.

Lastly, it is necessary to turn the attention of our economists to this matter, because backwardness in technical-economic calculations prevents the possibility of a correct examination of a large number of important problems.

END

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